US007728727B2

(12) **United States Patent**
Cox

(10) **Patent No.: US 7,728,727 B2**
(45) **Date of Patent: Jun. 1, 2010**

(54) **DYNAMIC INVENTORY DURING TRANSIT**

(75) Inventor: **Paul A Cox**, Albuquerque, NM (US)

(73) Assignee: **Honeywell International Inc.**, Morristown, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 482 days.

(21) Appl. No.: **11/381,808**

(22) Filed: **May 5, 2006**

(65) **Prior Publication Data**

US 2006/0255916 A1 Nov. 16, 2006

Related U.S. Application Data

(60) Provisional application No. 60/679,446, filed on May 10, 2005.

(51) **Int. Cl.**
G08B 13/14 (2006.01)

(52) **U.S. Cl.** **340/572.1**

(58) **Field of Classification Search** ... 340/572.1–572.9, 340/10.1, 5.92; 701/1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,774,876	A *	6/1998	Woolley et al.	705/28
6,195,006	B1	2/2001	Bowers et al.	340/572.1
6,236,911	B1 *	5/2001	Kruger	701/1
6,601,764	B1	8/2003	Goodwin, III	
6,693,539	B2	2/2004	Bowers et al.	340/572.1
6,919,803	B2 *	7/2005	Breed	340/539.14
6,973,385	B2 *	12/2005	Ulrich	701/207
7,173,530	B2 *	2/2007	Lambright et al.	340/572.8
7,259,669	B2 *	8/2007	Cargonja et al.	340/539.18
2006/0187043	A1 *	8/2006	Allen	340/572.1

OTHER PUBLICATIONS

Gallagher, "Aerospace RFID", "Avionics Magazine", Apr. 2008, pp. 38-42.

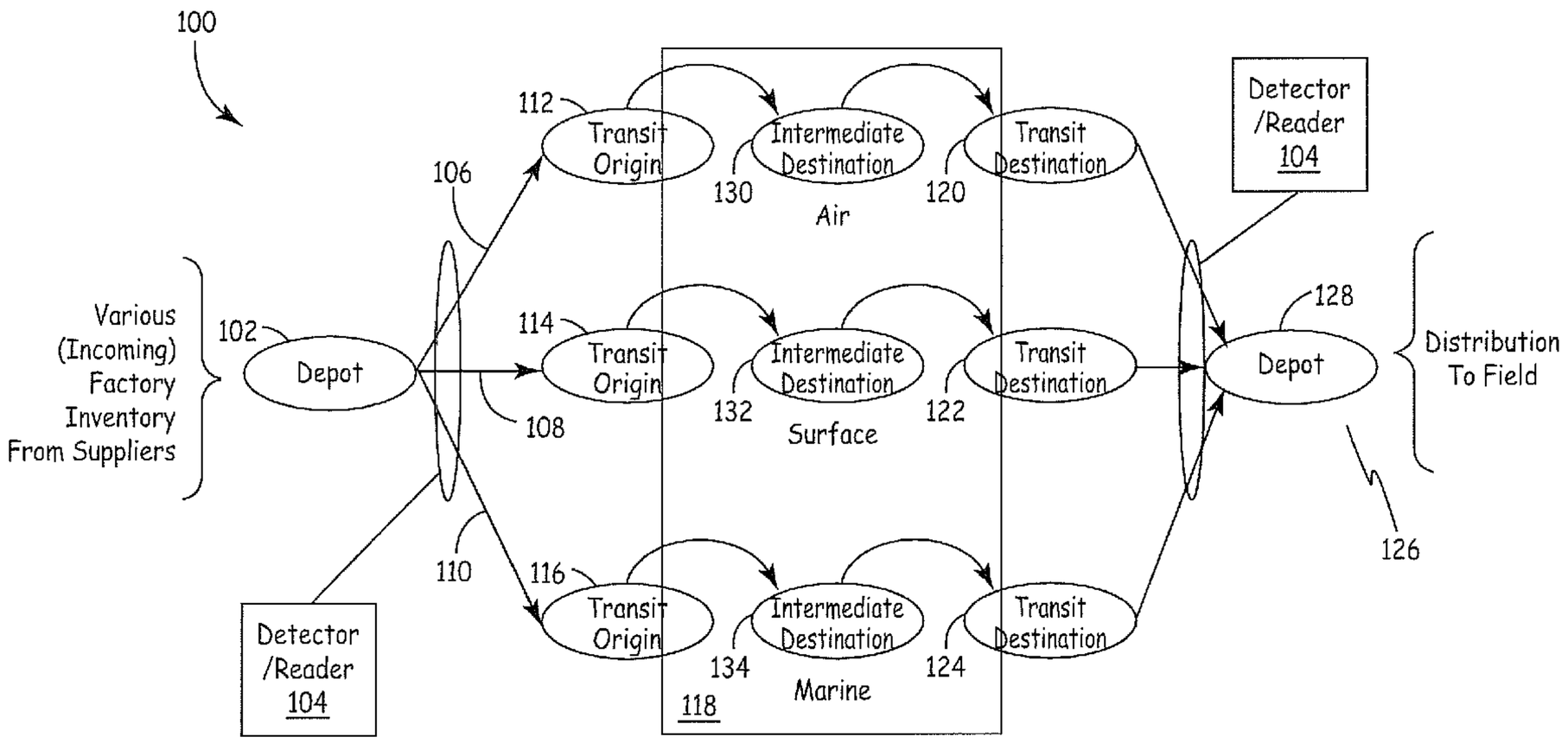
* cited by examiner

Primary Examiner—Phung Nguyen
(74) *Attorney, Agent, or Firm*—Fogg & Powers LLC

(57) **ABSTRACT**

A method of dynamically keeping inventory of items in a vehicle in transit is provided. The method includes detecting an event during transit and conducting interrogations of inventory based on the detected event. The method can compare these inventories to determine disposition of inventory items by location.

14 Claims, 4 Drawing Sheets



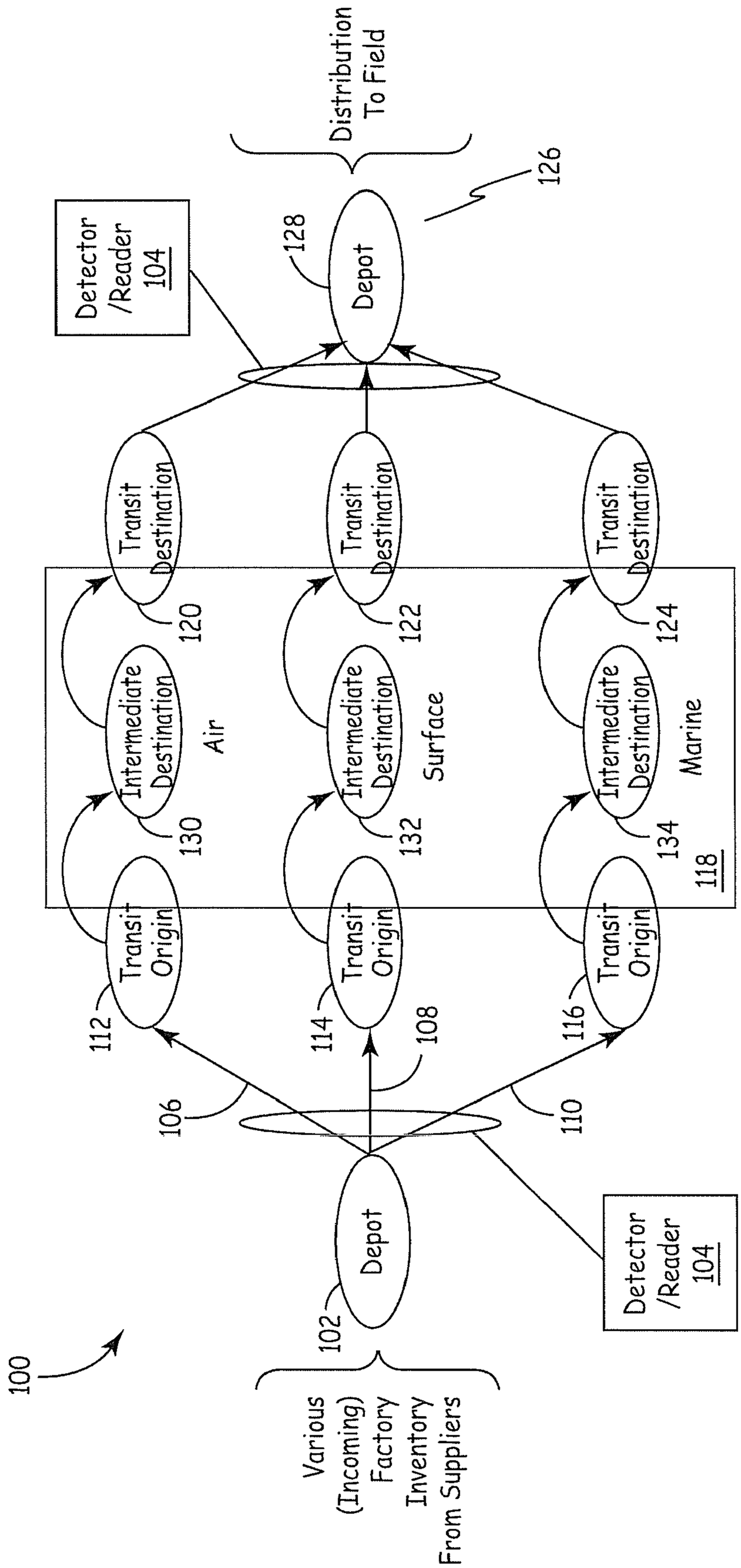

100
Various (Incoming) Factory Inventory From Suppliers
102
Depot
106
108
110
112
Transit Origin
114
Transit Origin
116
Transit Origin
118
Air
Surface
Marine
120
Transit Destination
122
Transit Destination
124
Transit Destination
126
128
Depot
130
Intermediate Destination
132
Intermediate Destination
134
Intermediate Destination
Distribution To Field
Detector /Reader 104
Detector /Reader 104

FIG. 1

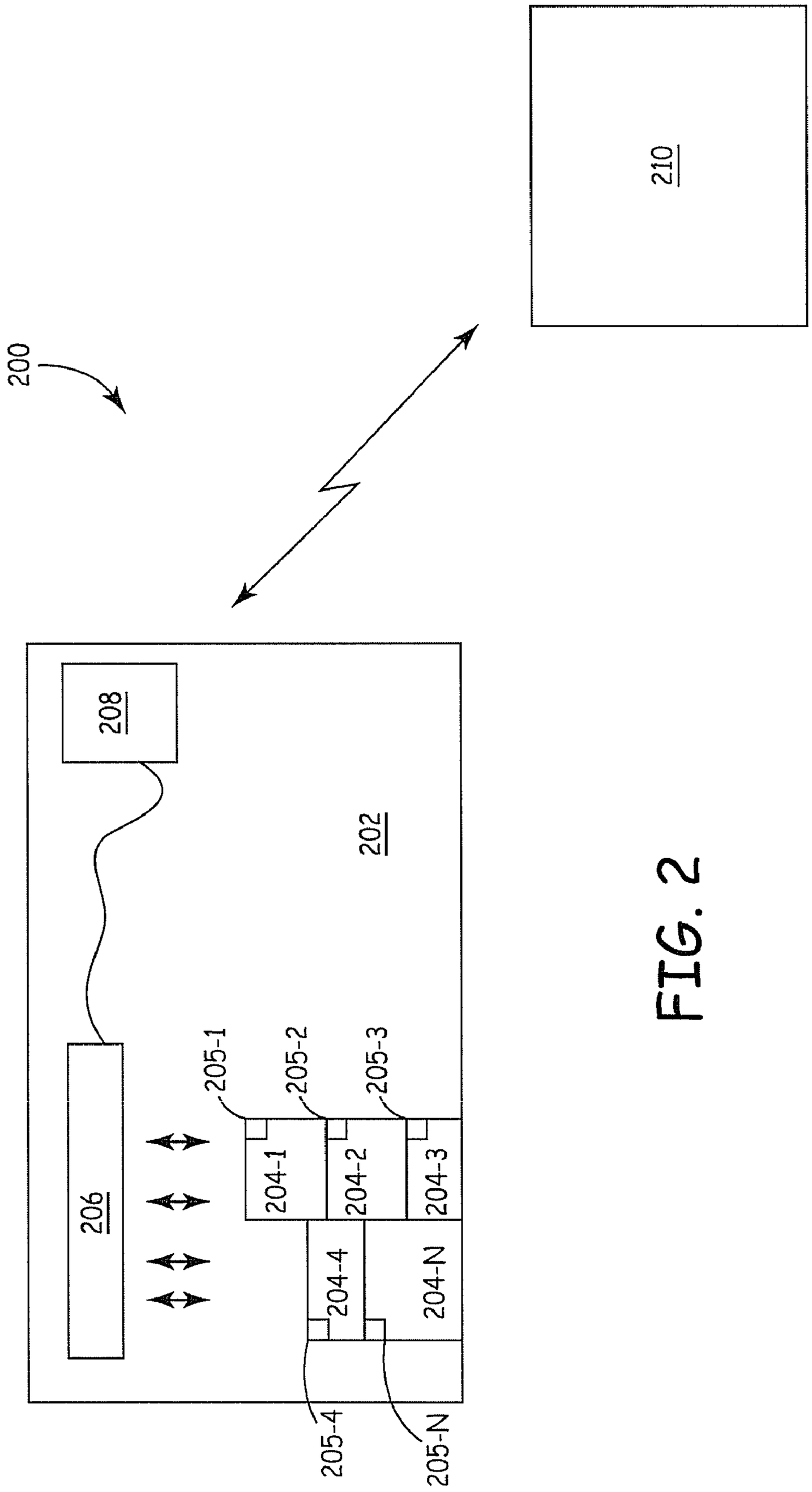

210
200
208
202
206
205-1
205-2
205-3
204-1
204-2
204-3
204-4
204-N
205-4
205-N

FIG. 2

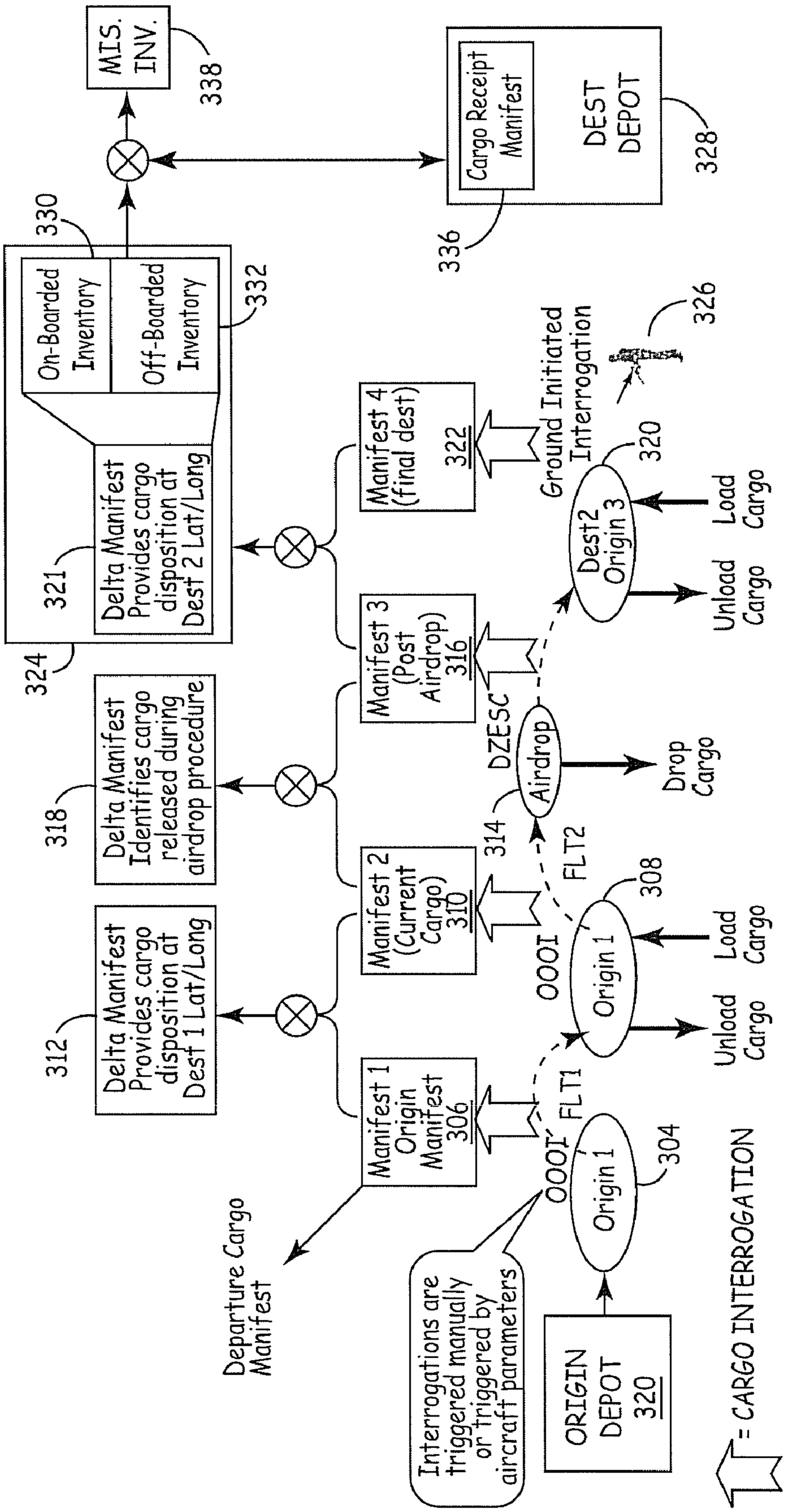

MIS. INV.
338
Cargo Receipt Manifest
DEST DEPOT
328
336
330
On-Boarded Inventory
Off-Boarded Inventory
332
321
Delta Manifest Provides cargo disposition at Dest 2 Lat/Long
324
318
Delta Manifest Identifies cargo released during airdrop procedure
312
Delta Manifest Provides cargo disposition at Dest 1 Lat/Long
Manifest 4 (final dest) 322
Manifest 3 (Post Airdrop) 316
Manifest 2 (Current Cargo) 310
Manifest 1 Origin Manifest 306
326
Ground Initiated Interrogation
320
Dest2 Origin 3
Load Cargo
Unload Cargo
DZESC
Airdrop
Drop Cargo
314
FLT2
OOOI
308
Origin 1
Load Cargo
Unload Cargo
FLT1
OOOI
Origin 1
304
Departure Cargo Manifest
Interrogations are triggered manually or triggered by aircraft parameters
ORIGIN DEPOT 320
= CARGO INTERROGATION

FIG. 3

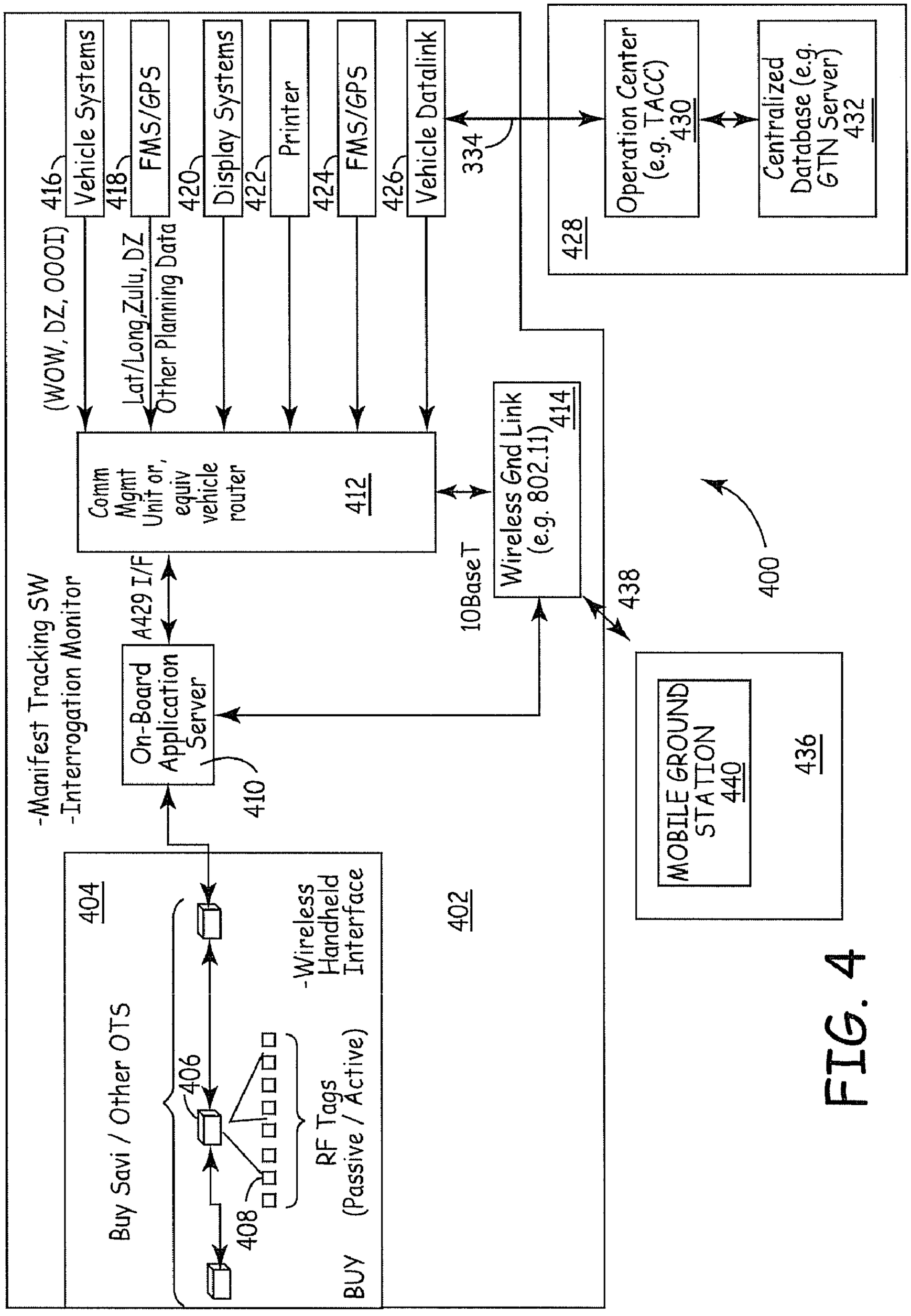

Vehicle Systems
416
FMS/GPS
418
Display Systems
420
Printer
422
FMS/GPS
424
Vehicle Datalink
426
334
428
Operation Center (e.g. TACC) 430
Centralized Database (e.g. GTN Server) 432
(WOW, DZ, OOOI)
Lat/Long,Zulu, DZ
Other Planning Data
Comm Mgmt Unit or, equiv vehicle router
412
A429 I/F
10BaseT
Wireless Gnd Link (e.g. 802.11) 414
On-Board Application Server
410
-Manifest Tracking SW
-Interrogation Monitor
438
400
MOBILE GROUND STATION 440
436
404
Buy Savi / Other OTS
406
408
RF Tags (Passive / Active)
-Wireless Handheld Interface
BUY
402

FIG. 4

DYNAMIC INVENTORY DURING TRANSIT

RELATED APPLICATIONS

This application claims the benefit of prior provisional application 60/679,446, filed May 10, 2005, which is incorporated in its entirety herein by reference.

BACKGROUND

Current inventory tracking systems track inventory of items being shipped by first checking the inventory at the shipping origination location and then at the receiving location. These inventories can then be compared to determine if something was lost in transit. One method used to simplify the taking of inventory is with the use identification tags such as electronic identification tags. An example of an electronic identification tag is passive or active radio frequency identification (RFID) tags. With this system each item, or group of items, has an RFID tag attached that contains information that identifies the item, or group of items. A sensor or reader at a known location simply reads the information off of the RFID tag when the item is passed through a detector/reader or passes within the vicinity of a reader.

One limitation of this system is that not all shipping locations and receiving location have detectors/readers to read the identification tags. Another limitation of the current system is that inventory can not be inventoried during transit, unless readers are present on the transportation vehicle. These vehicles equipped with readers can only report if the item is currently present on the vehicle, but can not provide insight in to the location of the inventoried item. Hence, events that occur during transit that effect the inventory cannot be monitored.

For the reasons stated above and for other reasons stated below which will become apparent to those skilled in the art upon reading and understanding the present specification, there is a need in the art for an efficient, automated method of inventorying items during transit on vehicles.

SUMMARY OF INVENTION

The above-mentioned problems of current systems are addressed by embodiments of the present invention and will be understood by reading and studying the following specification.

In one embodiment, a method of dynamically keeping inventory of items in a vehicle in transit is provided. The method includes detecting an event during transit and conducting a first interrogation of inventory based on the detected event.

In another embodiment, a computer-readable medium having computer-executable instructions for tracking inventory in a transport vehicle is provided. The computer-readable medium includes the methods of initiating interrogations of items in a vehicle in transit in response to the detection of one or more events and generating a manifest of the inventory based on each interrogation.

In still another embodiment an inventory tracking system is provided. The inventory tracking device includes an interrogation device and a control unit. The interrogation device is located in a transit vehicle and is adapted to read identification tags on items being transported. The control unit is adapted to control the interrogation device in response to an event.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be more easily understood and further advantages and uses thereof more readily apparent, when considered in view of the description of the preferred embodiments and the following figures in which:

FIG. **1** is a flow diagram illustrating one embodiment of the present invention;

FIG. **2**, is a block diagram of a dynamic inventory system of one embodiment of the present invention;

FIG. **3** is a flow diagram of another embodiment of the present invention; and

FIG. **4** is a block diagram of an inventory system of one embodiment of the present invention.

In accordance with common practice, the various described features are not drawn to scale but are drawn to emphasize specific features relevant to the present invention. Reference characters denote like elements throughout Figures and text.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific embodiments in which the inventions may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that logical, mechanical and electrical changes may be made without departing from the spirit and scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined only by the claims and equivalents thereof.

Embodiments of the present invention provide an efficient and effective method of tracking inventories while in transit. In embodiments, of the invention, interrogations of the inventory are conducted based on detected events. Manifests of the inventory are created based on the each interrogation. In one embodiment, a control unit that initiates an interrogation in a transport vehicle interfaces with on-board vehicle systems to monitor data used to determine the interrogation event and provide position (latitude and longitude) of the inventory to a remote unit. Referring to FIG. **1**, a flow diagram of a transit system **100** of one embodiment of the present invention is illustrated. As illustrated, various factory parts from suppliers for transit are provided to depot **102**. In this example, three types of transportation are provided, air, surface and marine. Path **106** is associated with the air transportation, path **108** is associated with the surface transportation and path **110** is associated with the marine transportation. Within the depot **102**, the items to be transported are typically passed through, or are located near, a detector/reader **104**. The detector/reader **104** is an interrogation system adapted to read electronic identification tags associated with each item to be transported. An example of an electronic identification tag is a passive or active RFID tag. Once the items have been passed through the detector/reader **104** they are placed in their respective vehicle for transit. Once the items are loaded, the items are at their respective transit origin **112**, **114** or **116**.

The items are then transported using their respective vehicle. This is the transit period **1 1 8**. In prior art method, once the items where on there respective vehicle for transit, there was no way to monitor the inventory until they where unloaded at a drop off sight that had a detector/reader adapted to read the inventory. As discussed above, that type of system is limited. In embodiments of the present invention an effective and efficient method of tracking the inventory while the inventory is in transit is provided. In embodiments of the present invention, the vehicle transporting the items includes

an interrogation system. The interrogation system is adapted to conduct an inventory of the items contained in the vehicle upon an event. In one embodiment, the event is a vehicle specific parameter such as when the vehicle reaches a select speed, altitude or when a door is opened or when a door is closed. In another embodiment, the event is an inventory signal that is generated from an operator of the vehicle or from a remote location such as an operation, maintenance, or logistic center. In further embodiments of the present invention, a delta manifest is created that tracks differences in inventories after each interrogation.

Referring back to FIG. **1**, when the inventory reaches an intermediate destination **130**, **132** or **134**, portions of the inventory may be removed and/or added to the transportation vehicle. In one embodiment the only detector/readers are located on the vehicle. Hence only items added to, or remaining on, the transportation vehicle can be inventoried. The inventory manifest is associated with the location (latitude and longitude) at which the inventory was obtained.

Referring back to FIG. **1**, when the inventory reaches its destination, it is at its respective transit destination **120**, **122** or **124**. The items are then pasted through, or near, detector/reader **126** so the inventory can be checked and then placed at depot **128** for further distribution. In some embodiments of the present invention, the need for detector/reader **104** and detector/reader **126** is eliminated since the inventory is dynamically checked throughout the transportation. In other embodiments, the detectors/readers **104** and **126** are used to verify results.

FIG. **2** illustrates a dynamic inventory system **200** of one embodiment of the present invention. This embodiment includes a transport vehicle **202** such a plane, truck or ship. The transport vehicle **202** is transporting items **204-1** through **204**-N. The transport vehicle also includes an interrogation system **206**. The interrogation system is adapted to read identification tags, such as identification tags **205-1** through **205**-N, that are associated with each item in conducting an inventory of the items **204** in the transport vehicle **202**. In one embodiment, the identification tags are electronic identification tags such as RFID passive or active tags. The interrogation system is coupled to control unit **208**. Control unit **208** is adapted to control the interrogation system **206**. In one embodiment, the control unit **208** is adapted to initiate an inventory upon the detection of an event associated with the transport vehicle **202**. For example, the event could be when the vehicle reaches a certain speed, when a select location (latitude/longitude) is passed, when a select altitude is reached, after a certain time has passed, etc. In another embodiment, an operator in the transport vehicle, or near the transit vehicle, can direct the control unit **208** to initiate an inventory upon command. In yet another embodiment, the event is a signal received from a remote control station **210** via wireless communication link **212**. In this embodiment, a distribution center or the like can direct the control unit **208** to initiate an inventory. Further in another embodiment, the control unit **208** is adapted to send the results of inventory, or delta inventory, to the remote control station **210**.

Referring to FIG. **3**, a flow diagram **300** of another embodiment of the present invention is illustrated. As illustrated, items at an origin depot **320** are loaded into an aircraft at origin **304**. Once the aircraft has taken to flight, a first manifest is created **306** by taking inventory of the cargo (items) with an inboard interrogation. The interrogation is directed either manually or triggered by aircraft parameters such as, aircraft speed, position (latitude/longitude), weight on wheels (WOW), drop zone (DZ), altitude, proximity sensors such as door closures out, off, on, in (OOOI) parameters, or triggered remotely through vehicles equipage sending messages to control unit **208**. In this example, the aircraft then reaches a first destination **308**. At this first destination **308**, cargo is unloaded and loaded. Once the aircraft unloading /loading is complete, or the aircraft has taken off from the first destination **308**, an interrogation is conducted and a second manifest **310** is created. In response to this second manifest **310**, a delta manifest **312** is created that compares the first manifest **306** with the second manifest **310** to determine what was loaded and unload at the first destination **308**. Further in this embodiment, an airdrop **314** location is provided by on-board vehicle system is encountered. After the airdrop **314**, an interrogation is taken and a third manifest is created **316** that contains the current inventory. Another delta manifest **318** is then created that compares the third manifest **316** from the second manifest **310** to determine what was unloaded at the airdrop. Hence disposition of inventory at a specific location is determined.

The aircraft then reaches the second destination **320** upon which cargo is unloaded and loaded. Upon completion of unloading/loading another interrogation is conducted. In one embodiment this interrogation can be initiated once the aircraft returns to flight. In another embodiment the interrogation is initiated by ground-based personnel **326** with a remote trigger device. A fourth manifest is then created **322** based on the interrogation that contains the then current inventory of the cargo. In this example, the forth manifest is compared with the second manifest **310** or the third manifest **316** to create delta manifest **324**. This illustrates the flexibility of creating delta manifests.

Delta Manifest **324** consists of two components, items off-loaded **332** from the vehicle, and items on-loaded **330** to the vehicle. The off-loaded items can then be compared to an expected cargo receipt manifest **336** present at the destination depot **328**. In one embodiment a missing inventory manifest **338** is created to capture which inventory items where not correct loaded/loaded.

Another embodiment of an inventory system **400** the present invention is illustrated in FIG. **4**. This embodiment includes a vehicle **402** and a remote operating location **428**. The vehicle **402** includes an inventory determining system **404**. The inventory determining system **404** includes one or more interrogation devices **406** which are adapted to read identification tags **408** on items. Also illustrated is an on-board application server **410**. The on-board application server **410** is adapted to control the interrogation device **406**. A communication management unit **412** is coupled to the on-board application server **410**. In one embodiment, the on-board application server **410** is in communication with the communication management unit **412** via wireless link **414**, or other electronic communication link such as ARINC 429, Mil-std-1553, Ethernet, fiber-optic, etc.

The communication management unit **412**, or equivalent data router, is adapted to interface communications between the on-board application server **410** and data sharing systems. The data sharing systems include vehicle system **416**, FMS/GPS/Navigation **418**, display system **420**, printer **422**, Electronic Flight Bag (or equivalent) **424**, and a vehicle data link **426**. The vehicle system **416** provides vehicle parameters such as WOW, DZ, OOOI and speed. The FMS/GPS **418** provide latitude, longitude, time, drop zone and other flight planning data. The display system **420** allows for the display of inventories determined by interrogations. The printer **422** provides a hard copy of inventories. The vehicle data link **426** provides two-way data link communications to an off-vehicle, or remote operating center.

A remote operating location **428** is also illustrated which allows for the remote operation of the inventory determining system **404** of the vehicle **402**. The remote operating location **428** includes an operating center **430** and a centralized database **432**. An example of an operating center **430** is the Military's Tanker Airlift Control Center (TACC), or commercial Airline Operations Control (AOC) Centers. The operating center is in communication with the vehicle datalink **426**. Examples of the communication medium **334** used include but are not limited to INMARSAT Satcom, VHF, HF, UHFDL, Iridum Satcom, Ku/Ka-Band Satcom, and telephony datalinks. Additionally the Aircraft system **402** may communicate with ground operators **436** mobile devices **440** via two-way datalink system **438**. Examples of ground-based datalink systems include but are not limited to wireless standards such as 802.11, 802.16, and Zigbee, and operate in a multitude of radio frequency ranges.

Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement, which is calculated to achieve the same purpose, may be substituted for the specific embodiment shown. This application is intended to cover any adaptations or variations of the present invention. Therefore, it is manifestly intended that this invention be limited only by the claims and the equivalents thereof.

The invention claimed is:

1. A method of dynamically keeping inventory of items in a vehicle in transit the method comprising:

detecting an event during transit; wherein the event is a signal that is transmitted remote from the vehicle;

conducting a first interrogation of inventory based on the detected signal that is transmitted remote from the vehicle;

creating a first manifest of items based on the first interrogation;

conducting a second interrogation after the detection of a second event;

creating a second manifest of items based on the second interrogation; and

creating a delta manifest by comparing the first manifest to the second manifest to determine a change inventory that indicates changes between the first and second manifests;

wherein vehicle position is associated with the first, second and delta manifests.

2. The method of claim **1**, wherein conducting the first interrogation further comprises:

reading identification tags on each item in the vehicle.

3. The method of claim **1**, further comprising:

conducting an additional interrogation of inventory based on detecting an operating parameter of the vehicle.

4. The method of claim **3**, wherein the operating parameter includes at least one of vehicle's local or zulu time, altitude, position (latitude/longitude), time in transit, proximity sensors/switch state change, cargo drop zone waypoint, navigation waypoints, throttle position, brake release, weight-on/off-wheels, or manual crew/operator initiation.

5. The method of claim **1**, wherein the second event is an airdrop event.

6. A computer-readable medium having computer-executable instructions for tracking inventory in a transport vehicle, the computer-readable medium including methods comprising:

initiating interrogations of items in a vehicle in transit in response to signals that are transmitted remote from the vehicle;

generating a plurality of manifests of inventory, each manifest of the inventory based on a respective interrogation; and

generating one or more delta manifests based on a comparison of two or more of the plurality of manifests, wherein vehicle position is associated with the plurality of manifests and the one or more delta manifests.

7. The computer-readable medium method of claim **6**,

wherein each of the one or more delta manifest comprises at least one of items removed from vehicle and items added to vehicle.

8. The computer-readable medium method of claim **6**, further comprising initiating additional interrogations based on the detection of a select parameter associated with the transport vehicle.

9. The computer readable medium of claim **8**, wherein the select parameter associated with the transport vehicle includes at least one of vehicle's local or zulu time, altitude, position (latitude/longitude), time in transit, proximity sensors/switch state change, cargo drop zone waypoint, navigation waypoints, throttle position, brake release, weight-on/off-wheels, or manual crew/operator initiation.

10. The computer-readable medium method of claim **6**, further comprising:

tagging each generated manifest with time and location information.

11. An inventory tracking system comprising:

an interrogation device located in a transit vehicle configured to read identification tags on items being transported; and

a control unit configured to control the interrogation device in response to signals sent remote from the transit vehicle directing the control unit to control the interrogation device to conduct an interrogation;

wherein the control unit is further configured to:

create a first manifest of items based on a first interrogation;

conduct a second interrogation after the detection of a second event;

create a second manifest of items based on the second interrogation; and

create a delta manifest by comparing the first manifest to the second manifest to determine a change inventory that indicates changes between the first and second manifests;

wherein vehicle position is associated with the first, second and delta manifests.

12. The inventory tracking device of claim **11**, wherein the control unit is adapted to detect a parameter associated with the transit vehicle.

13. The inventory tracking device of claim **11**, the control unit further configured to control the interrogation device in response to an event, wherein the event is at least one of vehicle's local or zulu time, altitude, position (latitude/longitude), time in transit, proximity sensors/switch state change, cargo drop zone waypoint, navigation waypoints, throttle position, brake release, weight-on/off-wheels, or manual crew/operator initiation.

14. The inventory tracking device of claim **11**, further comprising at least one of a wireless ground link, data sharing systems, a wireless airborne link and a wireless marine link.

* * * * *